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PATENT ABSTRACTS OF JAPAN

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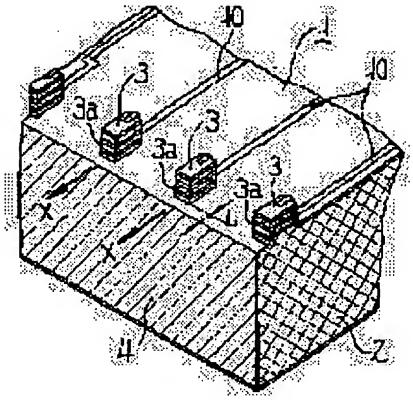
(54) SEMICONDUCTOR DEVICE WITH OPTICAL FIBER AND MANUFACTURE THEREOF

(57)Abstract:

PURPOSE: To provide a semiconductor device with optical fibers, capable of realizing a small-sized and inexpensive light transmitting module, and the manufacture thereof by contriving positioning between an end face light emitting type semiconductor element and the optical fibers.

CONSTITUTION: In a semiconductor light emitting device equipped with optical fibers, transmitting light emitted by light emitting units 3 through the optical fibers by connecting the optical fibers to the light emitting units 3 of an end face light emitting type semiconductor element 1 having a plurality of light emitting units 3 in the light emitting direction X of the light emitting units 3, the end face light emitting type semiconductor element 1 is cut and divided in orthogonal direction with respect to the light emitting directions X of the light emitting units 3 to form a sectional surface 4 while the sectional surface 4 is set as an optical connection positioning surface 4 for positioning upon incorporating works of the optical fibers into the semiconductor device.



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JAPANESE [JP,06-120564,A]

CLAIMS DETAILED DESCRIPTION TECHNICAL FIELD PRIOR ART EFFECT OF THE INVENTION TECHNICAL PROBLEM MEANS OPERATION EXAMPLE DESCRIPTION OF DRAWINGS DRAWINGS

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] By combining an optical fiber in the luminescence direction of said light-emitting part of the end-face luminescence mold semiconductor device which has two or more light-emitting parts In the semi-conductor luminescence equipment with an optical fiber which transmits the light which emitted light with said light-emitting part in said optical fiber The semiconductor device with an optical fiber characterized by setting it as the optical coupling alignment side which divides said end-face luminescence mold semiconductor device perpendicularly to the luminescence direction of that light-emitting part, forms a cutting plane, and performs alignment in the case of attachment by said optical fiber which should be combined of this cutting plane.
[Claim 2] The manufacture approach of the semiconductor device with an optical fiber characterized by attaching in one said end-face luminescence mold semiconductor device with which had the end-face luminescence mold semiconductor device which has two or more light-emitting parts, and the optical fiber in which the light which emitted light from said light-emitting part carries out incidence, and compare the luminescence side of the light-emitting part of said end-face luminescence mold semiconductor device, and the end face of said optical fiber, and it was made to join together, and was these-combined, and said optical fiber on a base side.
[Claim 3] The semiconductor device with an optical fiber according to claim 1 characterized by forming the alignment mark for performing alignment with the optical fiber which should be combined with this component at the end-face luminescence mold semiconductor device side which has two or more light-emitting parts at least.
[Claim 4] The semiconductor device with an optical fiber according to claim 1 or 3 which considers as the end-face luminescence mold semiconductor device which has two or more light-emitting parts, and is characterized by using a luminescence diode array.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to optical communication, optical LAN, the semiconductor device with an optical fiber further used as an optical transmission module, and its manufacture approach.
[0002]
[Description of the Prior Art] As an optical module for optical communication in the former, in order to enable a long distance, the object for inside short distance, and still high-reliability transmission, according to the application, a semi-conductor light emitting device and an optical fiber are combined variously, and are used. Generally as a semi-conductor light emitting device, semiconductor laser and light emitting diode are used. Moreover, as an optical fiber, the single mode mold, the field luminescence mold, etc. are used.
[0003] When performing transmission for long distances, it is used in the combination of semiconductor laser and a single mode mold optical fiber. In this case, using the point ball fiber to which the lens function was made to add as an optical fiber in order to realize efficient optical coupling of both components, in order to make immobilization of that optical fiber, and highly precise alignment with semiconductor laser perform, generally having adopted the Si-V slot (Institute of Electronics and Communication Engineers, S56, No.1815 grade) is performed. Moreover, semiconductor laser and a single mode mold optical fiber are attached, and precision doubling using the stereo microscope etc. as the manufacture approach at the time is needed (Shingaku Giho, Vol.91, No.197 grade).
[0004] Moreover, when performing transmission for inside short distance, the combination of a field luminescence mold light emitting diode (it is hereafter called the field luminescence LED) and a multimode fiber is used. In this case, since the core diameter is large about coupling of a multimode fiber (about 50 micrometers), precision is not required so much rather than the case of a single mode, but since neither the radiation pattern of the field luminescence LED currently used conventionally being perfect diffusion nor luminescence power is obtained enough and cannot secure S/N of the output signal by the side of light-receiving, a certain device of making a luminescence side and the input screen of a fiber approach etc. is needed.
[0005] It is common that carry out unification shaping, constitute a fiber from a ferrule etc. about the alignment of the luminescence side of the light-emitting part of a light emitting device and the end face of an optical fiber, make it combine with the module by the side of luminescence with a guide pin, and this is performing alignment.
[0006]
[Problem(s) to be Solved by the Invention] As a semi-conductor light emitting device for long distances, although semiconductor laser is generally used, since high-reliability is required, the control (auto power control) and the cure against heat to drive current variation by the temperature change are needed, and, thereby, a configuration is complicated. On the other hand, although the field luminescence type of light emitting diode (LED) is generally used, when attaining the high increase in power of the optical output needed from a lightwave transmission system, and improvement in the speed of a speed of response as a semi-conductor light emitting device for short distance, LED manufactured according to the usual planar structure must use LED with complicated structures, such as LED of mesa structure which was not used, for example, gave constriction structure of an inrush current, and lost current breadth and parasitic capacitance. Moreover, since it is field luminescence even if it faces coupling with an optical fiber, a certain device is needed on module structure, further, the mechanical dimensional accuracy as a module is needed, and a manufacture process also complicates the alignment by a guide pin etc.
[0007] Moreover, the single mode fiber which performed point ball processing used in order to reduce optical coupling loss from the former When it is made multicore structure, the point spherical diameter is crossed to multicore. Manufacture to homogeneity or It is difficult to solve the technical problem about controlling positioning at the tip of a fiber of the direction of an optical axis with a sufficient precision to homogeneity to the luminescence side of a semiconductor laser array, or industrial engineering. Consequently, when transmitting a lightwave signal to parallel, each coupling effectiveness of multicore differed, the difference of optical power arose between the lightwave signals which transmit each channel, it did not detect as a signal, or the disregard level needed to be amended, and it was troublesome.
[0008] Furthermore, although the V groove guide made from Si which can use the conventional semi-conductor process is used in order to position a semi-conductor light emitting device array and a fiber array with high precision Must carry out prolonged anisotropy wet etching by the KOH solution to the manufacture, and productive efficiency is bad and, moreover, also sets at the time of transmission module manufacture. If it takes into consideration that at least one piece is needed and highly precise [of the wearing process of the fiber mentioned above] is required about each module etc., a result which leads to the cost rise of the whole module will be brought.
[0009]
[Means for Solving the Problem] By combining an optical fiber in the luminescence direction of said light-emitting part of the end-face luminescence mold semiconductor device which has two or more light-emitting parts in invention according to claim 1 In the semi-conductor luminescence equipment with an optical fiber which transmits the light which emitted light with said light-emitting part in said optical fiber Said end-face luminescence mold semiconductor device was perpendicularly divided to the luminescence direction of that light-emitting part, the cutting plane was formed, and it was set as the optical coupling alignment side which performs alignment in the case of attachment by said optical fiber which should be combined of this cutting plane.
[0010] In invention according to claim 2, said end-face luminescence mold semiconductor device with which had the end-face

luminescence mold semiconductor device which has two or more light-emitting parts, and the optical fiber in which the light which emitted light from said light-emitting part carries out incidence, and compare the luminescence side of the light-emitting part of said end-face luminescence mold semiconductor device and the end face of said optical fiber, and it was made to join together, and was these-combined, and said optical fiber were attached in one on the base side.
[0011] The semiconductor device with an optical fiber according to claim 1 characterized by forming the alignment mark for performing alignment with the optical fiber which should be combined with this component at the end-face luminescence mold semiconductor device side which has two or more light-emitting parts at least in invention according to claim 1 in invention according to claim 3.
[0012] In invention according to claim 4, in invention according to claim 1 or 3, it considered as the end-face luminescence mold semiconductor device which has two or more light-emitting parts, and the luminescence diode array was used.
[0013]
[Function] in invention according to claim 1, by making the cutting plane of an end-face luminescence mold semiconductor device into an optical coupling alignment side, alignment with the optical fiber which should be combined can be performed easily, and, moreover thereby, the conventional mass-production nature is now — it becomes unnecessary to use the point ball fiber which is not established, and productivity can be made to improve
[0014] In invention according to claim 2, it becomes possible to perform certainly optical-axis doubling of an end-face luminescence mold semiconductor device and an optical fiber in the phase before equipping a module, and in order to take the manufacture approach which can perform wearing to a module simply moreover, the components mark at the time of attachment are reduced, and it becomes possible to shorten assembly time amount.
[0015] In invention according to claim 3, by having prepared the alignment mark, the alignment precision of the luminescence side of a light-emitting part and the end face of an optical fiber is raised, and it becomes possible to realize positive coupling.
[0016] In invention according to claim 4, luminescence power is increased and it becomes possible to raise joint effectiveness with an optical fiber.
[0017]
[Example] Claim 1 and one example of invention of four publications are explained based on drawing 1 – drawing 5 . First, the structure of an end-face luminescence mold semiconductor device is described based on drawing 1 and drawing 2 . Here, the end-face luminescence mold luminescence diode array 1 (it is hereafter called the end-face mold LEDA) is used as an end-face luminescence mold semiconductor device. This is the thing of the type which emits light in the direction perpendicular to the crystal growth direction of the semi-conductor epitaxial growth film unlike the conventional field luminescence mold.
[0018] Drawing 1 shows the end-face mold LEDA1, and the light-emitting part 3 which can be created according to well-known planar structure is formed with fixed spacing on the GaAs substrate 2. The cutting plane 4 which comes to divide the GaAs substrate 2 perpendicularly to that luminescence direction X is formed in the luminescence direction X of luminescence side 3a of this light-emitting part 3. Let this cutting plane 4 be a terrace (the following, terrace 4) as an optical coupling alignment side for performing alignment in the case of attachment by the optical fiber (optical fiber 5 mentioned later) which should be combined. The light-emitting part 3 is formed in the place of the distance L to the direction of an optical axis from this terrace 4 (henceforth, terrace length L) (this terrace length L is stated to a detail, while mentioning later). In addition, the circuit pattern 10 which consists of aluminum etc. is connected to the light-emitting part 3.
[0019] Moreover, drawing 2 shows the cross-section configuration of a light-emitting part 3, and on the GaAs substrate 2, a buffer layer 6, cladding layer 7a, a barrier layer 8, cladding layer 7b, and the gap layer 9 carry out the laminating of it one by one, and it is formed.
[0020] Since it is possible by considering as such a configuration to enlarge effectiveness which shuts up light within the barrier layer 8 of a light-emitting part 3 compared with a field luminescence mold, the luminescence power can be enlarged. Moreover, joint effectiveness (coupling effectiveness) with an optical fiber 5 can fully be taken by controlling the thickness of a barrier layer 8 with it being possible to narrow radiation accuracy of the perpendicular direction of a luminescence beam (it becoming a prolate ellipsoid longitudinal direction luminescence configuration), without becoming, consequently seldom caring about the alignment precision of a perpendicular direction with an optical fiber 5.
[0021] In this case, as an end-face luminescence mold semiconductor device, the two-dimensional side luminescence type for juxtaposition picture transmissions etc. is not special, and the semiconductor laser of the usual type used for optical communication etc. may be used as an object for inside long distances. In order to use a single mode fiber with a small core diameter bearing in mind that APC and a heat cure means are needed, about the alignment, it will become severer than the type of an "LED+ multimode fiber."
[0022] Next, the configuration at the time of attaching the end-face mold LEDA1 with an optical fiber 5, and carrying out it is explained based on drawing 3 – drawing 5 . In drawing 3 , by placing the end-face mold LEDA1 and an optical fiber 5 on the base 11 which has a level difference, and carrying out contact association of the terrace 4 of the end-face mold LEDA1, and the end-face 5a of an optical fiber 5, luminescence side 3a and end-face 5a have the terrace length L, and face each other. Moreover, although similarly combined on the flat base 11 in drawing 4 , the end-face mold LEDA1 is being fixed on the 11th page of the base through the Au bump 12 in this case.
[0023] In the case of an end-face luminescence mold, the terrace length L changes with fibers to be used, but If coupling effectiveness as shown in drawing 5 (a) and (b) is carried out from the result which carried out simulation In the case of butt coupling (it dashes and joins together) using the fiber which carried out the cross-section cut as shown in (a), dashing most often (L= 0) Moreover, as shown in (b), when the point ball fiber which performed spherical diameter processing is used at a tip, it turns out that the optimal value exists with the magnitude (the 60 micrometers wave a, the 70-micrometer wave b) of a point spherical diameter. Therefore, with the optical fiber 5 to choose, this terrace length L is set up and the end-face mold LEDA1 is manufactured. When it dashes, the terrace length L which had better shorten as much as possible and was designed is formed when performing cutting separation of the component on a LEDA manufacture process. The scribe method for using the dicing method and a cleavage like various kinds of wafers for semi-conductors as a means of this cutting separation is used.
[0024] As mentioned above, alignment with the optical fiber 5 which should be combined can be easily performed by making the cutting plane 4 of the end-face mold LEDA1 into an optical coupling alignment side (terrace 4). and thereby, the conventional mass-production nature is now — it becomes unnecessary to use the point ball fiber which is not established, and productivity can be made to improve
[0025] Next, one example of invention according to claim 2 is explained based on drawing 6 and drawing 7 . Here, how to combine

the end-face mold LEDA1 and an optical fiber 5, and to manufacture a semiconductor device with an optical fiber is described. It states based on the end-face mold LEDA1 and optical fiber 5 which compare luminescence side 3a of the light-emitting part 3 of the end-face mold LEDA1, and end-face 5a of an optical fiber 5, were combined with the manufacture approach here, and were these-combined, and attaches in one on the 11th page of - SU. Hereafter, the reason using such a manufacture approach is explained.

[0026] As shown in the conventional manufacture approach of drawing 7 , the substrate 13 for heat dissipation and the V groove guide 14 are arranged on the common base 11 by which the thermal design was carried out in consideration of the cure against heat dissipation, the coefficient of thermal expansion, etc., and there is a method of equipping the substrate 13 for heat dissipation with the end-face mold LEDA1, and equipping the V groove guide 14 with an optical fiber 5 separately, respectively. By such method of grapple, adhesion precision between the substrates 13 for heat dissipation and the bases 11 where the end-face mold LEDA1 was fixed, and adhesion precision between the V groove guide 14 made from Si and the base 11 must be made an issue of, respectively, it attaches, and a sex worsens. Then, first, as shown in drawing 6 of this example, compare luminescence side 3a of a light-emitting part 3, and end-face 5a of an optical fiber 5, it is made to join together, and adhesion immobilization is carried out on the 11th page of the base after that using the Au bump 12 or UV hardening resin 16 in the state of such coupling at the same time it equips firmly with the end-face mold LEDA1 and an optical fiber 5 a fixture 15 (what finally is not attached to a module). And the end-face mold LEDA1 with which it was equipped by doing in this way is mounted in the electrodes 10, such as aluminum wired on the base 11, through the Au bump 12, and an optical fiber 5 is pasted up on the base 11 as it is using UV hardening resin 16. In this case, since it does not remove from a fixture 15 during mounting and adhesion, a coupling condition can be held as it is. Thus, after adhesion immobilization is completed, desorption only of the fixture 15 is carried out and, thereby, attachment by the end-face mold LEDA1 and the optical fiber 5 is completed.

[0027] In addition, in sticking a fixture 15 and the end-face mold LEDA1, inside hole 15a is opened in the approach 15 of carrying out desorption later, for example, a fixture, and the vacuum pump draws, or it uses the approach of holding from the side face of the end-face mold LEDA1 and an optical fiber 5. Moreover, about a fixture 15, it needs to be especially careful of distance, a dimension, etc. between the bottom surface part of the end-face mold LEDA1, and the lower limit section of an optical fiber 5 so that the point of the end-face mold LEDA1 emitting light may come on the optical axis of an optical fiber 5. Moreover, when V groove structure which suited the fiber array pitch is given to the fixture 15, the advantage that it is not necessary to attach the V groove guide 14 made from Si to each module is in the array precision list of a fiber in respect of alignment with the end-face mold LEDA1. Since this should produce only a fixture 15 with a sufficient precision, it can tie to a cost cut. Furthermore, what is necessary is just to be able to take the rigidity which is extent in which V recessing is possible besides Si as an ingredient of a fixture 15. By taking such an approach, problems, such as maintenance of parallelism with the base 11 at the time of pressurization, are also solvable to highly-precise-izing of the alignment of base wiring and LEDA wiring, highly-precise-izing of the load (impulse force) control at the time of mounting of the face down bonder method, and a pan.

[0028] As mentioned above, by performing optical-axis doubling of the end-face mold LEDA1 and an optical fiber 5 in the phase before equipping a module, and moreover taking the manufacture approach which can perform wearing to a module simply, the components mark at the time of attachment can be reduced, and assembly time amount can be shortened sharply.

[0029] Next, one example of invention according to claim 3 is explained based on drawing 8 . Here, the alignment mark for performing correctly coupling alignment with the optical fiber 5 which should be combined with the component to the end-face mold LEDA1 side which has a light-emitting part 3 at least is formed. Drawing 8 (a) - (c) shows the example of the alignment mark. In (a), it is located in the cross-section section of the terrace 4 of the end-face mold LEDA1, and the mark 17 as an alignment mark is formed. Such a mark 17 is formed also in the V groove substrate 18 side holding an optical fiber 5 in (b). Furthermore, in (c), the guide rail 19 for the guide pins of a multicore fiber ferrule is formed along the top face of the end-face mold LEDA1 instead of a mark 17 as an alignment mark. In addition, you may make it use together a mark 17 and a guide rail 19.

[0030] Moreover, a mark 17 and a guide rail 19 are producible with dry etching, such as RIE of a semi-conductor process. In this case, although it is necessary to take the overhaul procedure of equipment into consideration, it is possible to dig even about 40 micrometers.

[0031] Thus, by having prepared the alignment mark, the alignment precision of the end-face mold LEDA1 and an optical fiber 5 can be raised, and positive coupling can be realized.

[0032]

[Effect of the Invention] Invention according to claim 1 by combining an optical fiber in the luminescence direction of said light-emitting part of the end-face luminescence mold semiconductor device which has two or more light-emitting parts In the semi-conductor luminescence equipment with an optical fiber which transmits the light which emitted light with said light-emitting part in said optical fiber Since it was set as the optical coupling alignment side which divides said end-face luminescence mold semiconductor device perpendicularly to the luminescence direction of that light-emitting part, forms a cutting plane, and performs alignment in the case of attachment by said optical fiber which should be combined of this cutting plane It becomes unnecessary to use the point ball fiber which is not established, and productivity can be made to improve, and small by this alignment with the optical fiber which should be combined can be performed easily, and, moreover thereby, the conventional mass-production nature is now — A low cost optical transmission module can be realized.

[0033] The end-face luminescence mold semiconductor device in which invention according to claim 2 has two or more light-emitting parts, It has the optical fiber which carries out incidence, and the light which emitted light from said light-emitting part compares the luminescence side of the light-emitting part of said end-face luminescence mold semiconductor device, and the end face of said optical fiber, and makes it join together. Since said end-face luminescence mold semiconductor device with which it was these-combined, and said optical fiber were attached in one on the base side In order to become possible to perform certainly optical-axis doubling of an end-face luminescence mold semiconductor device and an optical fiber in the phase before equipping a module and to take the manufacture approach which can perform wearing to a module simply moreover, The components mark at the time of attachment are reduced, assembly time amount can be shortened, a production cost can be reduced by this, and dependability can be raised.

[0034] In invention according to claim 1, at least, to the end-face luminescence mold semiconductor device side which has two or more light-emitting parts, invention according to claim 3 raises the alignment precision of the luminescence side of a light-emitting part, and the end face of an optical fiber, since it formed the alignment mark for performing alignment with the optical fiber which should be combined with this component, can realize positive coupling and, thereby, can raise the dependability on a module and a transmission system.

[0035] In invention according to claim 1 or 3, since invention according to claim 4 considered as the end-face luminescence mold semiconductor device which has two or more light-emitting parts and used the luminescence diode array, it increases luminescence power and can raise joint effectiveness with an optical fiber.

[Translation done.]

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TECHNICAL FIELD

[Industrial Application] This invention relates to optical communication, optical LAN, the semiconductor device with an optical fiber further used as an optical transmission module, and its manufacture approach.

[Translation done.]

PRIOR ART

[Description of the Prior Art] As an optical module for optical communication in the former, in order to enable a long distance, the object for inside short distance, and still high-reliability transmission, according to the application, a semi-conductor light emitting device and an optical fiber are combined variously, and are used. Generally as a semi-conductor light emitting device, semiconductor laser and light emitting diode are used. Moreover, as an optical fiber, the single mode mold, the field luminescence mold, etc. are used.

[0003] When performing transmission for long distances, it is used in the combination of semiconductor laser and a single mode mold optical fiber. In this case, using the point ball fiber to which the lens function was made to add as an optical fiber in order to realize efficient optical coupling of both components, in order to make immobilization of that optical fiber, and highly precise alignment with semiconductor laser perform, generally having adopted the Si-V slot (Institute of Electronics and Communication Engineers, S56, No.1815 grade) is performed. Moreover, semiconductor laser and a single mode mold optical fiber are attached, and precision doubling using the stereo microscope etc. as the manufacture approach at the time is needed (Shingaku Giho, Vol.91, No.197 grade).

[0004] Moreover, when performing transmission for inside short distance, the combination of a field luminescence mold light emitting diode (it is hereafter called the field luminescence LED) and a multimode fiber is used. In this case, since the core diameter is large about coupling of a multimode fiber (about 50 micrometers), precision is not required so much rather than the case of a single mode, but since neither the radiation pattern of the field luminescence LED currently used conventionally being perfect diffusion nor luminescence power is obtained enough and cannot secure S/N of the output signal by the side of light-receiving, a certain device of making a luminescence side and the input screen of a fiber approach etc. is needed.

[0005] It is common that carry out unification shaping, constitute a fiber from a ferrule etc. about the alignment of the luminescence side of the light-emitting part of a light emitting device and the end face of an optical fiber, make it combine with the module by the side of luminescence with a guide pin, and this is performing alignment.

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EFFECT OF THE INVENTION

[Effect of the Invention] Invention according to claim 1 is combining an optical fiber in the luminescence direction of said light-emitting part of the end-face luminescence mold semiconductor device which has two or more light-emitting parts, In the semiconductor luminescence equipment with an optical fiber which transmits the light which emitted light with said light-emitting part in said optical fiber Since it was set as the optical coupling alignment side which divides said end-face luminescence mold semiconductor device perpendicularly to the luminescence direction of that light-emitting part, forms a cutting plane, and performs alignment in the case of attachment by said optical fiber which should be combined of this cutting plane It becomes unnecessary to use the point ball fiber which is not established, and productivity can be made to improve, and small by this alignment with the optical fiber which should be combined can be performed easily, and, moreover thereby, the conventional mass-production nature is now — A low cost optical transmission module can be realized.
[0033] Invention according to claim 2 is an end-face luminescence mold semiconductor device which has two or more light-emitting parts, It has the optical fiber which carries out incidence, and the light which emitted light from said light-emitting part compares the luminescence side of the light-emitting part of said end-face luminescence mold semiconductor device, and the end face of said optical fiber, and makes it join together. Since said end-face luminescence mold semiconductor device with which it was these-combined, and said optical fiber were attached in one on the base side In order to become possible to perform certainly optical-axis doubling of an end-face luminescence mold semiconductor device and an optical fiber in the phase before equipping a module and to take the manufacture approach which can perform wearing to a module simply moreover, The components mark at the time of attachment are reduced, assembly time amount can be shortened, a production cost can be reduced by this, and dependability can be raised.
[0034] In invention according to claim 1, at least, to the end-face luminescence mold semiconductor device side which has two or more light-emitting parts, invention according to claim 3 raises the alignment precision of the luminescence side of a light-emitting part, and the end face of an optical fiber, since it formed the alignment mark for performing alignment with the optical fiber which should be combined with this component, can realize positive coupling and, thereby, can raise the dependability on a module and a transmission system.
[0035] In invention according to claim 1 or 3, since invention according to claim 4 considered as the end-face luminescence mold semiconductor device which has two or more light-emitting parts and used the luminescence diode array, it increases luminescence power and can raise joint effectiveness with an optical fiber.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] As a semi-conductor light emitting device for long distances, although semiconductor laser is generally used, since high-reliability is required, the control (auto power control) and the cure against heat to drive current variation by the temperature change are needed, and, thereby, a configuration is complicated. On the other hand, although the field luminescence type of light emitting diode (LED) is generally used, when attaining the high increase in power of the optical output needed from a lightwave transmission system, and improvement in the speed of a speed of response as a semi-conductor light emitting device for short distance, LED manufactured according to the usual planar structure must use LED with complicated structures, such as LED of mesa structure which was not used, for example, gave constriction structure of an inrush current, and lost current breadth and parasitic capacitance. Moreover, since it is field luminescence even if it faces coupling with an optical fiber, a certain device is needed on module structure, further, the mechanical dimensional accuracy as a module is needed, and a manufacture process also complicates the alignment by a guide pin etc.

[0007] Moreover, the single mode fiber which performed point ball processing used in order to reduce optical coupling loss from the former When it is made multicore structure, the point spherical diameter is crossed to multicore. Manufacture to homogeneity or It is difficult to solve the technical problem about controlling positioning at the tip of a fiber of the direction of an optical axis with a sufficient precision to homogeneity to the luminescence side of a semiconductor laser array, or industrial engineering. Consequently, when transmitting a lightwave signal to parallel, each coupling effectiveness of multicore differed, the difference of optical power arose between the lightwave signals which transmit each channel, it did not detect as a signal, or the disregard level needed to be amended, and it was troublesome.

[0008] Furthermore, although the V groove guide made from Si which can use the conventional semi-conductor process is used in order to position a semi-conductor light emitting device array and a fiber array with high precision Must carry out prolonged anisotropy wet etching by the KOH solution to the manufacture, and productive efficiency is bad and, moreover, also sets at the time of transmission module manufacture. If it takes into consideration that at least one piece is needed and highly precise [of the wearing process of the fiber mentioned above] is required about each module etc., a result which leads to the cost rise of the whole module will be brought.

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MEANS

[Means for Solving the Problem] By combining an optical fiber in the luminescence direction of said light-emitting part of the end-face luminescence mold semiconductor device which has two or more light-emitting parts in invention according to claim 1 In the semi-conductor luminescence equipment with an optical fiber which transmits the light which emitted light with said light-emitting part in said optical fiber Said end-face luminescence mold semiconductor device was perpendicularly divided to the luminescence direction of that light-emitting part, the cutting plane was formed, and it was set as the optical coupling alignment side which performs alignment in the case of attachment by said optical fiber which should be combined of this cutting plane.
[0010] In invention according to claim 2, said end-face luminescence mold semiconductor device with which had the end-face luminescence mold semiconductor device which has two or more light-emitting parts, and the optical fiber in which the light which emitted light from said light-emitting part carries out incidence, and compare the luminescence side of the light-emitting part of said end-face luminescence mold semiconductor device and the end face of said optical fiber, and it was made to join together, and was these-combined, and said optical fiber were attached in one on the base side.
[0011] The semiconductor device with an optical fiber according to claim 1 characterized by forming the alignment mark for performing alignment with the optical fiber which should be combined with this component at the end-face luminescence mold semiconductor device side which has two or more light-emitting parts at least in invention according to claim 1 in invention according to claim 3.
[0012] In invention according to claim 4, in invention according to claim 1 or 3, it considered as the end-face luminescence mold semiconductor device which has two or more light-emitting parts, and the luminescence diode array was used.

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3.In the drawings, any words are not translated.

OPERATION

[Function] in invention according to claim 1, by making the cutting plane of an end-face luminescence mold semiconductor device into an optical coupling alignment side, alignment with the optical fiber which should be combined can be performed easily, and, moreover thereby, the conventional mass-production nature is now — it becomes unnecessary to use the point ball fiber which is not established, and productivity can be made to improve
[0014] In invention according to claim 2, it becomes possible to perform certainly optical-axis doubling of an end-face luminescence mold semiconductor device and an optical fiber in the phase before equipping a module, and in order to take the manufacture approach which can perform wearing to a module simply moreover, the components mark at the time of attachment are reduced, and it becomes possible to shorten assembly time amount.
[0015] In invention according to claim 3, by having prepared the alignment mark, the alignment precision of the luminescence side of a light-emitting part and the end face of an optical fiber is raised, and it becomes possible to realize positive coupling.
[0016] In invention according to claim 4, luminescence power is increased and it becomes possible to raise joint effectiveness with an optical fiber.

[Translation done.]

EXAMPLE

[Example] Claim 1 and one example of invention of four publications are explained based on drawing 1 - drawing 5 . First, the structure of an end-face luminescence mold semiconductor device is described based on drawing 1 and drawing 2 . Here, the end-face luminescence mold luminescence diode array 1 (it is hereafter called the end-face mold LEDA) is used as an end-face luminescence mold semiconductor device. This is the thing of the type which emits light in the direction perpendicular to the crystal growth direction of the semi-conductor epitaxial growth film unlike the conventional field luminescence mold.
[0018] Drawing 1 shows the end-face mold LEDA1, and the light-emitting part 3 which can be created according to well-known planar structure is formed with fixed spacing on the GaAs substrate 2. The cutting plane 4 which comes to divide the GaAs substrate 2 perpendicularly to that luminescence direction X is formed in the luminescence direction X of luminescence side 3a of this light-emitting part 3. Let this cutting plane 4 be a terrace (the following, terrace 4) as an optical coupling alignment side for performing alignment in the case of attachment by the optical fiber (optical fiber 5 mentioned later) which should be combined. The light-emitting part 3 is formed in the place of the distance L to the direction of an optical axis from this terrace 4 (henceforth, terrace length L) (this terrace length L is stated to a detail, while mentioning later). In addition, the circuit pattern 10 which consists of aluminum etc. is connected to the light-emitting part 3.
[0019] Moreover, drawing 2 shows the cross-section configuration of a light-emitting part 3, and on the GaAs substrate 2, a buffer layer 6, cladding layer 7a, a barrier layer 8, cladding layer 7b, and the gap layer 9 carry out the laminating of it one by one, and it is formed.
[0020] Since it is possible by considering as such a configuration to enlarge effectiveness which shuts up light within the barrier layer 8 of a light-emitting part 3 compared with a field luminescence mold, the luminescence power can be enlarged. Moreover, joint effectiveness (coupling effectiveness) with an optical fiber 5 can fully be taken by controlling the thickness of a barrier layer 8 with it being possible to narrow radiation accuracy of the perpendicular direction of a luminescence beam (it becoming a prolate ellipsoid longitudinal direction luminescence configuration), without becoming, consequently seldom caring about the alignment precision of a perpendicular direction with an optical fiber 5.
[0021] In this case, as an end-face luminescence mold semiconductor device, the two-dimensional side luminescence type for juxtaposition picture transmissions etc. is not special, and the semiconductor laser of the usual type used for optical communication etc. may be used as an object for inside long distances. In order to use a single mode fiber with a small core diameter bearing in mind that APC and a heat cure means are needed, about the alignment, it will become severer than the type of an "LED+ multimode fiber."
[0022] Next, the configuration at the time of attaching the end-face mold LEDA1 with an optical fiber 5, and carrying out it is explained based on drawing 3 - drawing 5 . In drawing 3 , by placing the end-face mold LEDA1 and an optical fiber 5 on the base 11 which has a level difference, and carrying out contact association of the terrace 4 of the end-face mold LEDA1, and the end-face 5a of an optical fiber 5, luminescence side 3a and end-face 5a have the terrace length L, and face each other. Moreover, although similarly combined on the flat base 11 in drawing 4 , the end-face mold LEDA1 is being fixed on the 11th page of the base through the Au bump 12 in this case.
[0023] In the case of an end-face luminescence mold, the terrace length L changes with fibers to be used, but If coupling effectiveness as shown in drawing 5 (a) and (b) is carried out from the result which carried out simulation In the case of butt coupling (it dashes and joins together) using the fiber which carried out the cross-section cut as shown in (a), dashing most often (L= 0) Moreover, as shown in (b), when the point ball fiber which performed spherical diameter processing is used at a tip, it turns out that the optimal value exists with the magnitude (the 60 micrometers wave a, the 70-micrometer wave b) of a point spherical diameter. Therefore, with the optical fiber 5 to choose, this terrace length L is set up and the end-face mold LEDA1 is manufactured. When it dashes, the terrace length L which had better shorten as much as possible and was designed is formed when performing cutting separation of the component on a LEDA manufacture process. The scribe method for using the dicing method and a cleavage like various kinds of wafers for semi-conductors as a means of this cutting separation is used.
[0024] As mentioned above, alignment with the optical fiber 5 which should be combined can be easily performed by making the cutting plane 4 of the end-face mold LEDA1 into an optical coupling alignment side (terrace 4). and thereby, the conventional mass-production nature is now -- it becomes unnecessary to use the point ball fiber which is not established, and productivity can be made to improve
[0025] Next, one example of invention according to claim 2 is explained based on drawing 6 and drawing 7 . Here, how to combine the end-face mold LEDA1 and an optical fiber 5, and to manufacture a semiconductor device with an optical fiber is described. It states based on the end-face mold LEDA1 and optical fiber 5 which compare luminescence side 3a of the light-emitting part 3 of the end-face mold LEDA1, and end-face 5a of an optical fiber 5, were combined with the manufacture approach here, and were these-combined, and attaches in one on the 11th page of - SU. Hereafter, the reason using such a manufacture approach is explained.
[0026] As shown in the conventional manufacture approach of drawing 7 , the substrate 13 for heat dissipation and the V groove guide 14 are arranged on the common base 11 by which the thermal design was carried out in consideration of the cure against heat dissipation, the coefficient of thermal expansion, etc., and there is a method of equipping the substrate 13 for heat dissipation with the end-face mold LEDA1, and equipping the V groove guide 14 with an optical fiber 5 separately, respectively. By such method of grapple, adhesion precision between the substrates 13 for heat dissipation and the bases 11 where the end-face mold LEDA1 was fixed, and adhesion precision between the V groove guide 14 made from Si and the base 11 must be made an issue of,

respectively, it attaches, and a sex worsens. Then, first, as shown in drawing 6 of this example, compare luminescence side 3a of a light-emitting part 3, and end-face 5a of an optical fiber 5, it is made to join together, and adhesion immobilization is carried out on the 11th page of the base after that using the Au bump 12 or UV hardening resin 16 in the state of such coupling at the same time it equips firmly with the end-face mold LEDA1 and an optical fiber 5 a fixture 15 (what finally is not attached to a module). And the end-face mold LEDA1 with which it was equipped by doing in this way is mounted in the electrodes 10, such as aluminum wired on the base 11, through the Au bump 12, and an optical fiber 5 is pasted up on the base 11 as it is using UV hardening resin 16. In this case, since it does not remove from a fixture 15 during mounting and adhesion, a coupling condition can be held as it is. Thus, after adhesion immobilization is completed, desorption only of the fixture 15 is carried out and, thereby, attachment by the end-face mold LEDA1 and the optical fiber 5 is completed.

[0027] In addition, in sticking a fixture 15 and the end-face mold LEDA1, inside hole 15a is opened in the approach 15 of carrying out desorption later, for example, a fixture, and the vacuum pump draws, or it uses the approach of holding from the side face of the end-face mold LEDA1 and an optical fiber 5. Moreover, about a fixture 15, it needs to be especially careful of distance, a dimension, etc. between the bottom surface part of the end-face mold LEDA1, and the lower limit section of an optical fiber 5 so that the point of the end-face mold LEDA1 emitting light may come on the optical axis of an optical fiber 5. Moreover, when V groove structure which suited the fiber array pitch is given to the fixture 15, the advantage that it is not necessary to attach the V groove guide 14 made from Si to each module is in the array precision list of a fiber in respect of alignment with the end-face mold LEDA1. Since this should produce only a fixture 15 with a sufficient precision, it can tie to a cost cut. Furthermore, what is necessary is just to be able to take the rigidity which is extent in which V recessing is possible besides Si as an ingredient of a fixture 15. By taking such an approach, problems, such as maintenance of parallelism with the base 11 at the time of pressurization, are also solvable to highly-precise-izing of the alignment of base wiring and LEDA wiring, highly-precise-izing of the load (impulse force) control at the time of mounting of the face down bonder method, and a pan.

[0028] As mentioned above, by performing optical-axis doubling of the end-face mold LEDA1 and an optical fiber 5 in the phase before equipping a module, and moreover taking the manufacture approach which can perform wearing to a module simply, the components mark at the time of attachment can be reduced, and assembly time amount can be shortened sharply.

[0029] Next, one example of invention according to claim 3 is explained based on drawing 8 . Here, the alignment mark for performing correctly coupling alignment with the optical fiber 5 which should be combined with the component to the end-face mold LEDA1 side which has a light-emitting part 3 at least is formed. Drawing 8 (a) - (c) shows the example of the alignment mark. In (a), it is located in the cross-section section of the terrace 4 of the end-face mold LEDA1, and the mark 17 as an alignment mark is formed. Such a mark 17 is formed also in the V groove substrate 18 side holding an optical fiber 5 in (b). Furthermore, in (c), the guide rail 19 for the guide pins of a multicore fiber ferrule is formed along the top face of the end-face mold LEDA1 instead of a mark 17 as an alignment mark. In addition, you may make it use together a mark 17 and a guide rail 19.

[0030] Moreover, a mark 17 and a guide rail 19 are producible with dry etching, such as RIE of a semi-conductor process. In this case, although it is necessary to take the overhaul procedure of equipment into consideration, it is possible to dig even about 40 micrometers.

[0031] Thus, by having prepared the alignment mark, the alignment precision of the end-face mold LEDA1 and an optical fiber 5 can be raised, and positive coupling can be realized.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view showing the configuration of the end-face luminescence mold semiconductor device which are claim 1 and one example of invention of four publications.
[Drawing 2] It is the sectional view showing the configuration of the light-emitting part of an end-face luminescence mold semiconductor device.
[Drawing 3] It is the side elevation showing the attachment condition of an end-face luminescence mold semiconductor device and an optical fiber.
[Drawing 4] It is the side elevation showing the attachment condition of an end-face luminescence mold semiconductor device and an optical fiber.
[Drawing 5] The property Fig. in which (a) shows the joint effectiveness over the amount of direction gaps of an optical axis in end-face association, and (b) are the property Figs. showing the joint effectiveness over the amount of direction gaps of an optical axis in the case of a point ball fiber.
[Drawing 6] It is the side elevation showing the approach of of the end-face luminescence mold semiconductor device and optical fiber which are one example of invention according to claim 2 "grapple."
[Drawing 7] The side elevation showing the semiconductor device with an optical fiber by which (a) was produced by the conventional method of grapple, and (b) are the front views seen from the optical fiber end-face side.
[Drawing 8] It is the perspective view showing the configuration of various kinds of alignment marks which are one example of invention according to claim 3.
[Description of Notations]
1 End-Face Luminescence Mold Semiconductor Device
3 Light-emitting Part
3a Luminescence side
4 Cutting Plane (Optical Coupling Alignment Side)
5 Optical Fiber
17 19 Alignment mark
X The luminescence direction

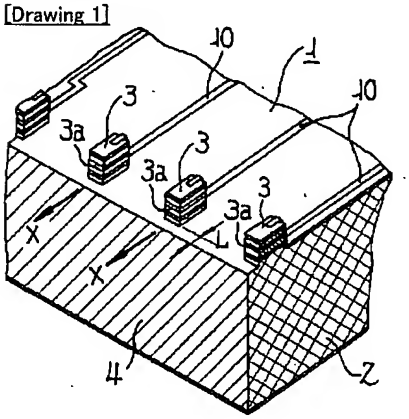
[Translation done.]

*.NOTICES *

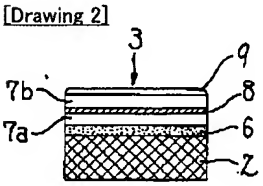
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

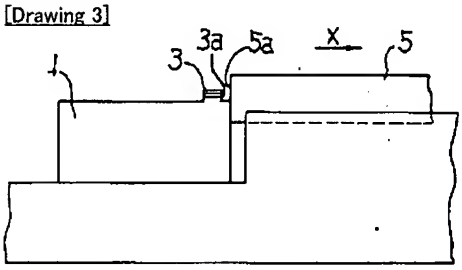
[Drawing 1]



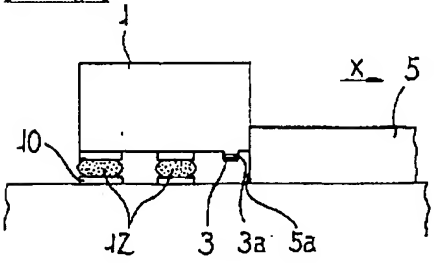
[Drawing 2]



[Drawing 3]

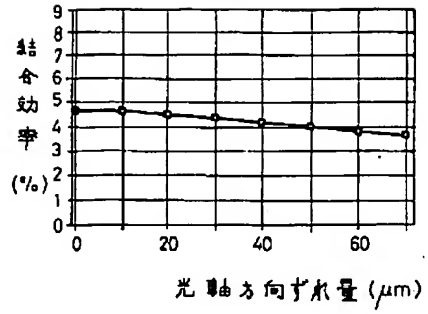


[Drawing 4]

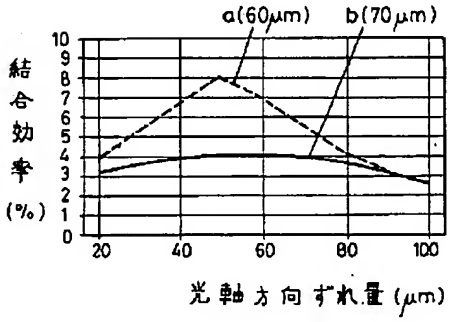


[Drawing 5]

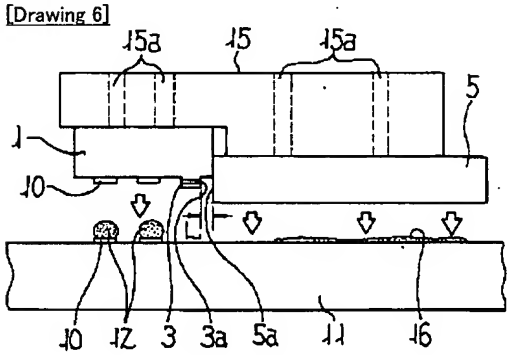
(a)



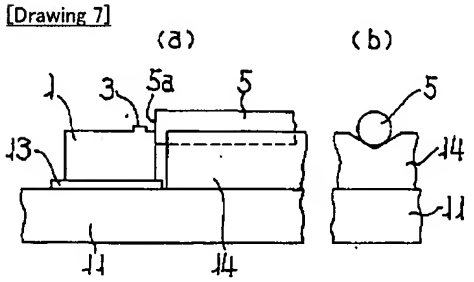
(b)



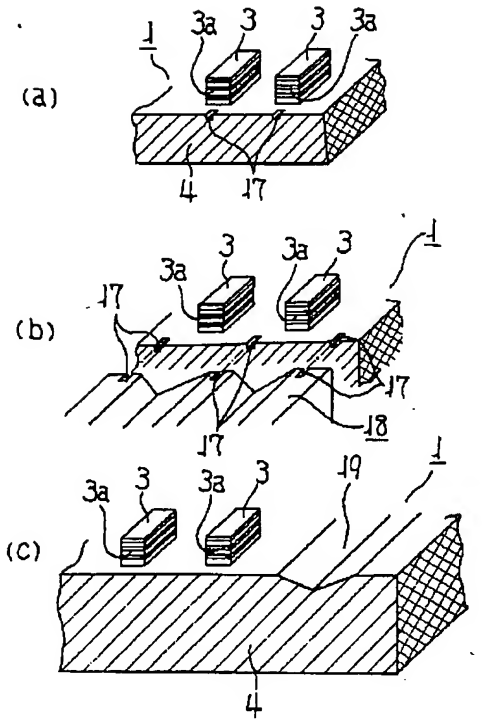
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]

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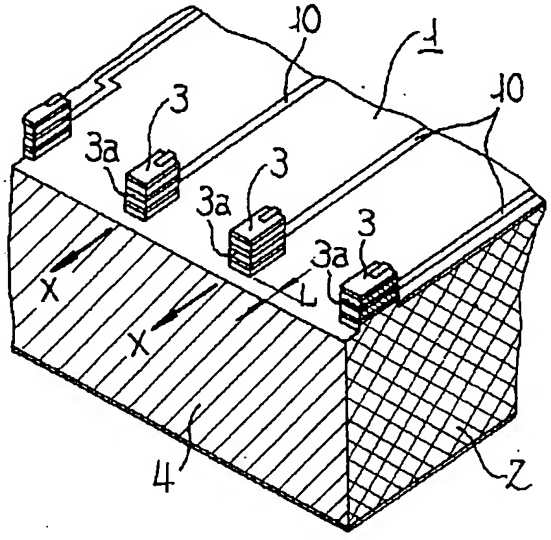
(54)【発明の名称】　光ファイバ付き半導体装置及びその製造方法

(57)【要約】

【目的】　端面発光型半導体素子と光ファイバとの位置合わせを工夫することにより、小型で低コストな光伝送モジュールを実現させることが可能な光ファイバ付き半導体装置及びその製造方法を提供する。

【構成】　発光部３を複数個有する端面発光型半導体素子１の発光部３の発光方向Ｘに光ファイバを結合させることにより、発光部３により発光された光を光ファイバ内に伝送する光ファイバ付き半導体発光装置において、端面発光型半導体素子１をその発光部３の発光方向Ｘに対して垂直方向に分断して切断面４を形成し、この切断面４を結合すべき光ファイバとの組付けの際の位置合わせを行う光結合位置合わせ面４に設定した。



【特許請求の範囲】
【請求項１】　発光部を複数個有する端面発光型半導体素子の前記発光部の発光方向に光ファイバを結合させることにより、前記発光部により発光された光を前記光ファイバ内に伝送する光ファイバ付き半導体発光装置において、前記端面発光型半導体素子をその発光部の発光方向に対して垂直方向に分断して切断面を形成し、この切断面を前記結合すべき光ファイバとの組付けの際の位置合わせを行う光結合位置合わせ面に設定したことを特徴とする光ファイバ付き半導体装置。
【請求項２】　発光部を複数個有する端面発光型半導体素子と、前記発光部から発光した光が入射する光ファイバとを備え、前記端面発光型半導体素子の発光部の発光面と前記光ファイバの端面とを突き合わせて結合させ、これら結合された前記端面発光型半導体素子と前記光ファイバとを基盤面上に一体的に組付けたことを特徴とする光ファイバ付き半導体装置の製造方法。
【請求項３】　少なくとも、発光部を複数個有する端面発光型半導体素子側に、この素子と結合すべき光ファイバとの位置合わせを行うための位置合わせマークを形成したことを特徴とする請求項１記載の光ファイバ付き半導体装置。
【請求項４】　発光部を複数個有する端面発光型半導体素子として、発光ダイオードアレイを用いたことを特徴とする請求項１又は３記載の光ファイバ付き半導体装置。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は、光通信や光ＬＡＮ、さらには光伝送モジュールとして利用される光ファイバ付き半導体装置及びその製造方法に関する。
【０００２】
【従来の技術】従来における光通信用光モジュールとしては、長距離、中短距離用、さらには高信頼性な伝送を可能とするために、半導体発光素子と光ファイバとを用途に応じて種々組み合わせて用いている。半導体発光素子としては一般的に半導体レーザと発光ダイオードとが用いられている。また、光ファイバとしてはシングルモード型や面発光型等が用いられている。
【０００３】長距離用の伝送を行う場合には、半導体レーザとシングルモード型光ファイバとの組合せで用いられている。この場合、両方の素子の効率の良い光結合を実現するために、光ファイバとしてレンズ機能を付加させた先球ファイバを用い、その光ファイバの固定及び半導体レーザとの高精度な位置合わせを行わせるためにＳｉ－Ｖ溝（電子通信学会、Ｓ５６、Ｎｏ．１８１５等）を採用しているのが一般的に行われている。また、半導体レーザとシングルモード型光ファイバとを組付け時の製造方法としては、ステレオ顕微鏡等を用いた精密合わせが必要となる（信学技報、Ｖｏｌ．９１、Ｎｏ．１９７等）。
【０００４】また、中短距離用の伝送を行う場合には、面発光型発光ダイオード（以下、面発光ＬＥＤと呼ぶ）とマルチモードファイバとの組合せが用いられている。この場合、マルチモードファイバのカップリングについては、コア径が大きい（５０μｍ程）ことから、シングルモードの場合よりも精度はそれほど要求されないが、従来使用されている面発光ＬＥＤの放射パターンが完全拡散であることや、発光パワーが十分得られず受光側の出力信号のＳ／Ｎが確保できないことから、発光面とファイバの入力面とを近接させる等の何らかの工夫が必要となる。
【０００５】発光素子の発光部の発光面と光ファイバの端面との位置合わせに関しては、ファイバをフェルール等で一体化成形して構成し、ガイドピンで発光側のモジュールと結合させ、これにより位置合わせを行っているのが一般的である。
【０００６】
【発明が解決しようとする課題】長距離用の半導体発光素子としては、半導体レーザを一般的に用いているが、高信頼性が要求されることから、温度変化による駆動電流変動に対する制御（オートパワーコントロール）や熱対策が必要となり、これにより構成が複雑化する。一方、短距離用の半導体発光素子としては、発光ダイオード（ＬＥＤ）の面発光タイプが一般的に用いられているが、光伝送システム上から必要とされる光出力の高出力化や応答速度の高速化を図るような場合には、通常のプレーナ構造により製造されるＬＥＤは使用されず、例えば注入電流の狭窄構造を施して電流広がりや寄生容量をなくしたメサ構造のＬＥＤなどの複雑な構造をもつＬＥＤを用いなければならない。また、光ファイバとのカップリングに際しても面発光であるためモジュール構造上何らかの工夫が必要となり、さらに、ガイドピン等による位置合わせも、モジュールとしての機械的な寸法精度が必要となり製作工程が複雑化する。
【０００７】また、従来から光結合損失を低減するために用いられている先球加工を施したシングルモードファイバは、多芯構造にした場合、その先球径を多芯に渡って均一に製作したり、半導体レーザアレイの発光面に対して光軸方向のファイバ先端の位置決めを精度良く均一に制御することや生産技術に関する課題を解決することが難しく、その結果、光信号をパラレルに伝送する場合、多芯の個々のカップリング効率が異なってしまい、各チャンネルを伝送する光信号間に光パワーの差が生じて信号として検出できなかったり、検出レベルの補正を行う必要があり面倒であった。
【０００８】さらに、半導体発光素子アレイとファイバアレイとを高精度に位置決めするために、従来の半導体プロセスを使用できるＳｉ製Ｖ溝ガイドを用いているが、その製造にはＫＯＨ溶液による長時間の異方性ウェ

ットエッチングを行わなければならず生産効率が悪く、しかも、伝送モジュール製作時においても、各モジュールについて少なくとも１個は必要となり、上述したファイバの装着工程の高精度さが要求されること等を考え合わせると、モジュール全体のコストアップにつながる結果となる。

【０００９】

【課題を解決するための手段】請求項１記載の発明では、発光部を複数個有する端面発光型半導体素子の前記発光部の発光方向に光ファイバを結合させることにより、前記発光部により発光された光を前記光ファイバ内に伝送する光ファイバ付き半導体発光装置において、前記端面発光型半導体素子をその発光部の発光方向に対して垂直方向に分断して切断面を形成し、この切断面を前記結合すべき光ファイバとの組付けの際の位置合わせを行う光結合位置合わせ面に設定した。

【００１０】請求項２記載の発明では、発光部を複数個有する端面発光型半導体素子と、前記発光部から発光した光が入射する光ファイバとを備え、前記端面発光型半導体素子の発光部の発光面と前記光ファイバの端面とを突き合わせて結合させ、これら結合された前記端面発光型半導体素子と前記光ファイバとを基盤面上に一体的に組付けた。

【００１１】請求項３記載の発明では、請求項１記載の発明において、少なくとも、発光部を複数個有する端面発光型半導体素子側に、この素子と結合すべき光ファイバとの位置合わせを行うための位置合わせマークを形成したことを特徴とする請求項１記載の光ファイバ付き半導体装置。

【００１２】請求項４記載の発明では、請求項１又は３記載の発明において、発光部を複数個有する端面発光型半導体素子として発光ダイオードアレイを用いた。

【００１３】

【作用】請求項１記載の発明においては、端面発光型半導体素子の切断面を光結合位置合わせ面とすることにより、結合すべき光ファイバとの位置合わせを簡単に行うことができ、しかも、これにより従来の量産性が今だ確立されていない先球ファイバを用いる必要がなくなり、生産性を改善させることができる。

【００１４】請求項２記載の発明においては、モジュールに装着する前の段階で端面発光型半導体素子と光ファイバとの光軸合わせを確実に行うことが可能となり、しかも、モジュールへの装着が簡単にできるような製造方法をとるため、組付け時の部品点数を低減させ、組立て時間を短縮させることが可能となる。

【００１５】請求項３記載の発明においては、位置合わせマークを設けたことにより、発光部の発光面と光ファイバの端面との位置合わせ精度を向上させ、確実なカップリングを実現することが可能となる。

【００１６】請求項４記載の発明においては、発光パワーを増大させ、光ファイバとの結合効率を高めることが可能となる。

【００１７】

【実施例】請求項１，４記載の発明の一実施例を図１～図５に基づいて説明する。まず、端面発光型半導体素子の構造を図１及び図２に基づいて述べる。ここでは、端面発光型半導体素子として、端面発光型発光ダイオードアレイ１（以下、端面型ＬＥＤＡと呼ぶ）を用いたものである。これは、従来の面発光型とは異なり、半導体エピタキシャル成長膜の結晶成長方向に垂直な方向に発光するタイプのものである。

【００１８】図１はその端面型ＬＥＤＡ１を示すものであり、ＧａＡｓ基板２上には、周知のプレーナ構造により作成可能な発光部３が一定間隔をもって形成されている。この発光部３の発光面３ａの発光方向Ｘには、ＧａＡｓ基板２をその発光方向Ｘに対して垂直に分断してなる切断面４が形成されている。この切断面４は、結合すべき光ファイバ（後述する光ファイバ５）との組付けの際の位置合わせを行うための光結合位置合わせ面としてのテラス（以下、テラス４）とされている。このテラス４からの光軸方向への距離Ｌ（以下、テラス長Ｌ）のところに、発光部３が設けられている（このテラス長Ｌについては、後述する中で詳細に述べる）。なお、発光部３には、Ａｌ等からなる配線パターン１０が接続されている。

【００１９】また、図２は発光部３の断面形状を示すものであり、ＧａＡｓ基板２上には、バッファ層６と、クラッド層７ａと、活性層８と、クラッド層７ｂと、ギャップ層９とが順次積層して形成されている。

【００２０】このような構成とすることにより、面発光型にくらべて、発光部３の活性層８内で光を閉じ込める効果を大きくすることが可能なため、その発光パワーを大きくすることができる。また、活性層８の膜厚をコントロールすることによって、発光ビームの垂直方向の放射確度を狭くすることが可能（横方向の長楕円な発光形状になる）となり、その結果、光ファイバ５との垂直方向の位置合わせ精度をあまり気にせずに、光ファイバ５との結合効率（カップリング効率）を十分にとることができる。

【００２１】この場合、端面発光型半導体素子としては、並列画像伝送用２次元面発光タイプ等の特別なものではなく、中長距離用として、例えば光通信等に使用される通常タイプの半導体レーザを用いてもよい。ＡＰＣや熱対策手段が必要となることを念頭におかなければならないし、コア径の小さなシングルモードファイバを用いるため、その位置合わせについては「ＬＥＤ＋マルチモードファイバ」のタイプよりは厳しいものとなる。

【００２２】次に、端面型ＬＥＤＡ１を光ファイバ５と組付けした場合の構成を図３～図５に基づいて説明する。図３では、端面型ＬＥＤＡ１と光ファイバ５とは、

段差を有するベース１１上に置かれ、端面型ＬＥＤＡ１のテラス４と光ファイバ５の端面５ａとを接触結合させることにより、発光面３ａと端面５ａとがテラス長Ｌをもって向かい合うようになっている。また、図４では、平坦なベース１１上で同様にして結合されているが、この場合、端面型ＬＥＤＡ１はＡｕバンプ１２を介してベース１１面上に固定されている。

【００２３】端面発光型の場合、テラス長Ｌは、使用するファイバ等によって異なってくるが、図５（ａ）（ｂ）に示すようなカップリング効率をシミュレーションした結果からすれば、（ａ）のように断面カットしたファイバを用いたｂｕｔｔカップリング（突き当て結合）の場合は突き当てるのが一番よく（Ｌ＝０）、また、（ｂ）のように先端に球径加工を施した先球ファイバを用いた場合には、先球径の大きさ（６０μｍの波形ａ，７０μｍの波形ｂ）によって最適な値が存在することがわかる。従って、選択する光ファイバ５によってこのテラス長Ｌを設定して端面型ＬＥＤＡ１を製造するようにする。突き当てた場合は、できるだけ短くした方がよく、設計されたテラス長Ｌは、ＬＥＤＡ製造プロセス上の素子の切断分離を行う時に形成される。この切断分離の手段としては、半導体用の各種のウェハと同様にダイシング法とかへき開を利用するスクライブ法を用いる。

【００２４】上述したように、端面型ＬＥＤＡ１の切断面４を光結合位置合わせ面（テラス４）とすることにより、結合すべき光ファイバ５との位置合わせを簡単に行うことができる。しかも、これにより従来の量産性が今だ確立されていない先球ファイバを用いる必要がなくなり、生産性を改善させることができる。

【００２５】次に、請求項２記載の発明の一実施例を図６及び図７に基づいて説明する。ここでは、端面型ＬＥＤＡ１と光ファイバ５とを結合して光ファイバ付き半導体装置を製造する方法について述べる。ここでの製造方法とは、端面型ＬＥＤＡ１の発光部３の発光面３ａと光ファイバ５の端面５ａとを突き合わせて結合させ、これら結合された端面型ＬＥＤＡ１と光ファイバ５とを基盤としてのベース１１面上に一体的に組付けたものである。以下、このような製造方法を用いた理由について述べる。

【００２６】図７の従来の製造方法に示すように、放熱対策や熱膨張係数等を考慮し熱設計された共通のベース１１上に放熱用基板１３とＶ溝ガイド１４を配置させ、放熱用基板１３には端面型ＬＥＤＡ１を、Ｖ溝ガイド１４には光ファイバ５をそれぞれ別個に装着する方法がある。このような組付け方法では、端面型ＬＥＤＡ１の固定された放熱用基板１３とベース１１との間の接着精度と、Ｓｉ製のＶ溝ガイド１４とベース１１との間の接着精度とをそれぞれ問題にしなければならず組付け性が悪くなる。そこで、本実施例の図６に示すように、まず、治具１５（最終的にはモジュールに組付けないもの）に端面型ＬＥＤＡ１と光ファイバ５とをしっかり装着すると同時に、発光部３の発光面３ａと光ファイバ５の端面５ａとを突き合わせて結合させ、その後、このようなカップリング状態でＡｕバンプ１２やＵＶ硬化樹脂１６を用いてベース１１面上に接着固定する。そして、このようにして装着された端面型ＬＥＤＡ１をベース１１上に配線されたＡｌ等の電極１０にＡｕバンプ１２を介して実装し、光ファイバ５はＵＶ硬化樹脂１６を用いてそのままベース１１上に接着させる。この場合、実装及び接着中は治具１５から外さないため、カップリング状態はそのまま保持することができる。このようにして接着固定が終了した後に、治具１５のみを脱着させ、これにより端面型ＬＥＤＡ１と光ファイバ５との組付けが完了する。

【００２７】なお、治具１５と端面型ＬＥＤＡ１とを密着させる場合には、あとで脱着できるような方法、例えば、治具１５に中穴１５ａを開けておき、真空ポンプで引き付けておくとか、端面型ＬＥＤＡ１と光ファイバ５との側面から保持するなどの方法を用いる。また、治具１５に関しては、端面型ＬＥＤＡ１の発光点が光ファイバ５の光軸上にくるように、特に端面型ＬＥＤＡ１の底面部と光ファイバ５の下端部との間の距離や寸法等の注意をする必要がある。また、治具１５にファイバアレイピッチに適合したＶ溝構造を施しておくと、ファイバの配列精度並びに端面型ＬＥＤＡ１との位置合わせの点で、Ｓｉ製のＶ溝ガイド１４を各モジュールに付けなくてよいという利点がある。これにより、治具１５だけ精度よく作製すればよいため、コストダウンにつなげることができる。さらに、治具１５の材料としては、Ｓｉの他に、Ｖ溝加工が可能である程度の剛性がとれるものであればよい。このような方法をとることにより、ベース配線とＬＥＤＡ配線との位置合わせの高精度化や、フェースダウンボンダ法のマウント時の荷重（衝撃力）制御の高精度化、さらには、加圧時のベース１１との平行度の維持等の問題も解決することができる。

【００２８】上述したように、モジュールに装着する前の段階で端面型ＬＥＤＡ１と光ファイバ５との光軸合わせを行い、しかも、モジュールへの装着が簡単にできるような製造方法をとることにより、組付け時の部品点数を低減させ、組立て時間を大幅に短縮させることができる。

【００２９】次に、請求項３記載の発明の一実施例を図８に基づいて説明する。ここでは、少なくとも発光部３を有する端面型ＬＥＤＡ１側に、その素子と結合すべき光ファイバ５とのカップリング位置合わせを正確に行うための位置合わせマークを形成したものである。図８（ａ）～（ｃ）はその位置合わせマークの具体例を示すものである。（ａ）では、端面型ＬＥＤＡ１のテラス４の断面部に位置して、位置合わせマークとしてのマーク

１７を形成したものである。（ｂ）では、そのようなマーク１７を、光ファイバ５を保持するＶ溝基板１８側にも形成したものである。さらに、（ｃ）では、位置合わせマークとして、マーク１７の代わりに、端面型ＬＥＤＡ１の上面に沿って多芯ファイバフェルールのガイドピン用の案内溝１９を形成したものである。なお、マーク１７や案内溝１９を併用するようにしてもよい。

【００３０】また、マーク１７や案内溝１９は、半導体プロセスのＲＩＥ等のドライエッチングにより作製することができる。この場合、装置のオーバーホールを考慮する必要はあるが、４０μｍ位まで掘ることは可能である。

【００３１】このように位置合わせマークを設けたことにより、端面型ＬＥＤＡ１と光ファイバ５の位置合わせ精度を向上させ、確実なカップリングを実現することができる。

【００３２】

【発明の効果】請求項１記載の発明は、発光部を複数個有する端面発光型半導体素子の前記発光部の発光方向に光ファイバを結合させることにより、前記発光部により発光された光を前記光ファイバ内に伝送する光ファイバ付き半導体発光装置において、前記端面発光型半導体素子をその発光部の発光方向に対して垂直方向に分断して切断面を形成し、この切断面を前記結合すべき光ファイバとの組付けの際の位置合わせを行う光結合位置合わせ面に設定したので、結合すべき光ファイバとの位置合わせを簡単に行うことができ、しかも、これにより従来の量産性が今だ確立されていない先球ファイバを用いる必要がなくなり、生産性を改善させることができ、これにより、小型で、低コストな光伝送モジュールを実現させることができるものである。

【００３３】請求項２記載の発明は、発光部を複数個有する端面発光型半導体素子と、前記発光部から発光した光が入射する光ファイバとを備え、前記端面発光型半導体素子の発光部の発光面と前記光ファイバの端面とを突き合わせて結合させ、これら結合された前記端面発光型半導体素子と前記光ファイバとを基盤面上に一体的に組付けたので、モジュールに装着する前の段階で端面発光型半導体素子と光ファイバとの光軸合わせを確実に行うことが可能となり、しかも、モジュールへの装着が簡単にできるような製造方法をとるため、組付け時の部品点数を低減させ、組立て時間を短縮させることができ、これにより生産コストを低減させ、信頼性を向上させることができるものである。

【００３４】請求項３記載の発明は、請求項１記載の発明において、少なくとも、発光部を複数個有する端面発光型半導体素子側に、この素子と結合すべき光ファイバとの位置合わせを行うための位置合わせマークを形成したので、発光部の発光面と光ファイバの端面との位置合わせ精度を向上させ、確実なカップリングを実現することができ、これによりモジュール及び伝送システム上の信頼性を向上させることができるものである。

【００３５】請求項４記載の発明は、請求項１又は３記載の発明において、発光部を複数個有する端面発光型半導体素子として発光ダイオードアレイを用いたので、発光パワーを増大させ、光ファイバとの結合効率を高めることができるものである。

【図面の簡単な説明】

【図１】請求項１，４記載の発明の一実施例である端面発光型半導体素子の構成を示す斜視図である。

【図２】端面発光型半導体素子の発光部の形状を示す断面図である。

【図３】端面発光型半導体素子と光ファイバとの組付け状態を示す側面図である。

【図４】端面発光型半導体素子と光ファイバとの組付け状態を示す側面図である。

【図５】（ａ）は端面結合の場合における光軸方向ずれ量に対する結合効率を示す特性図、（ｂ）は先球ファイバの場合における光軸方向ずれ量に対する結合効率を示す特性図である。

【図６】請求項２記載の発明の一実施例である端面発光型半導体素子と光ファイバとの組付け方法を示す側面図である。

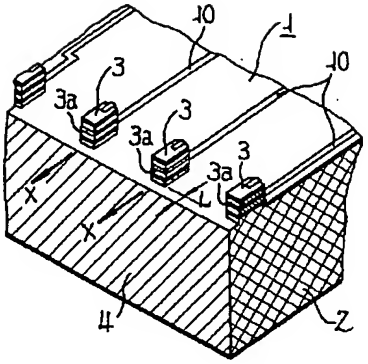
【図７】（ａ）は従来の組付け方法により作製された光ファイバ付き半導体装置を示す側面図、（ｂ）はその光ファイバ端面側からみた正面図である。

【図８】請求項３記載の発明の一実施例である各種の位置合わせマークの形状を示す斜視図である。

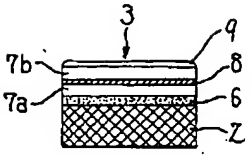
【符号の説明】

１	端面発光型半導体素子
３	発光部
３ａ	発光面
４	切断面（光結合位置合わせ面）
５	光ファイバ
１７，１９	位置合わせマーク
Ｘ	発光方向

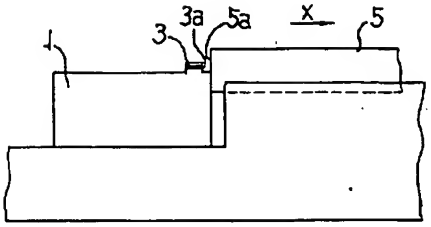
【図1】



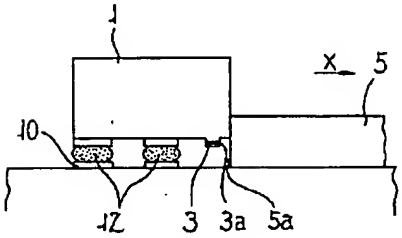
【図2】



【図3】

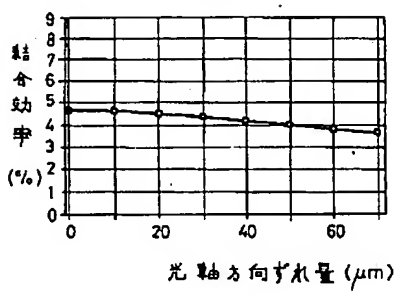


【図4】

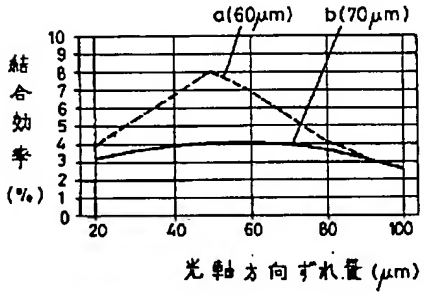


【図5】

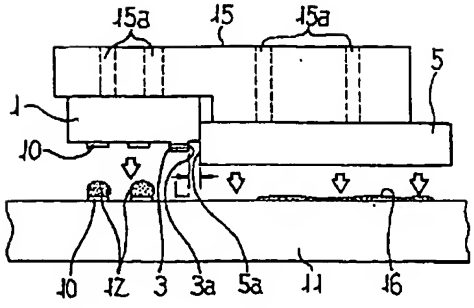
(a)



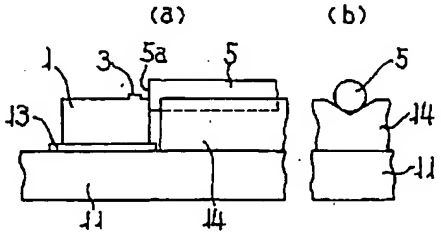
(b)



【図6】



【図7】



【図８】